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THE LIME, SULFUR AND SALT WASH FOR THE SAN JOSE SCALE.

By A. L. Quaintance, State Entomologist.

So much interest is being manifested at the present time in the lime, sulfur and salt wash as a treatment for trees and plants infested with the San Jose scale, that it has appeared desirable to present a

more extended account concerning its preparation and use, than has been given in Circular Bulletins 44 and 45 of this Department. Interest in this insecticide on the part of orchardists is by no means confined to our own State, and from the present outlook, it would appear that this wash will soon be quite generally adopted in the East as the standard treatment to keep the scale under control.

As is very well known, this treatment has been almost exclusively relied upon by the orchardists of the Pacific Coast for many years past in the control of the scale; and while it has proven

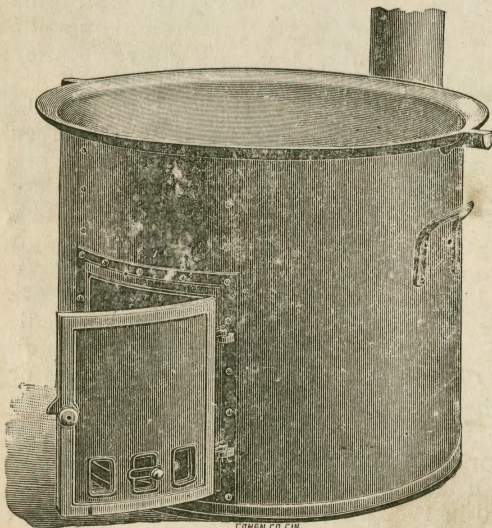


FIG. 1.

quite satisfactory, yet it is to be noted that not infrequently fruit more

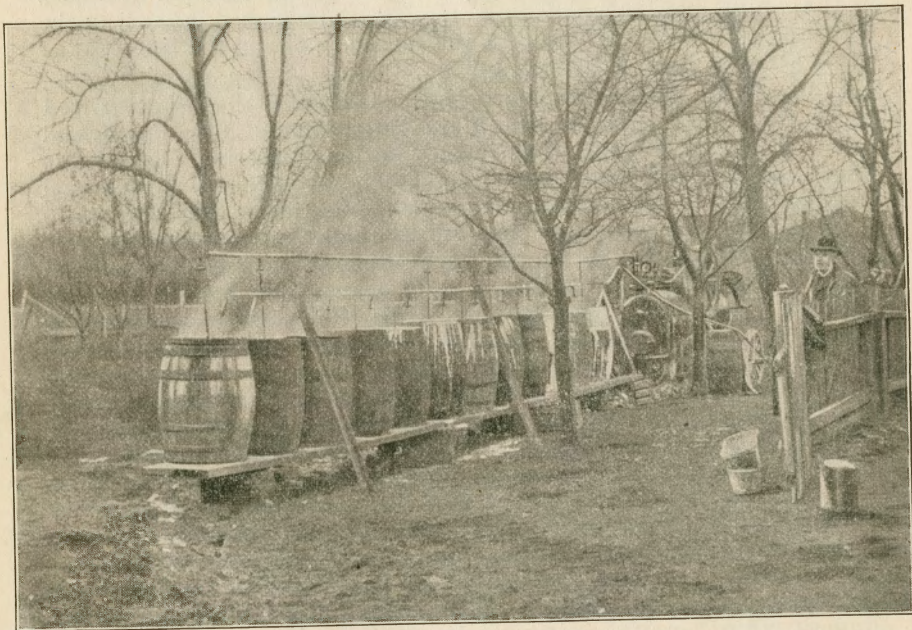
or less infested with the scale finds its way to our Eastern markets. This results probably more from imperfect spraying, or from failure to spray at all, than from the ineffectiveness of the wash. There can be no doubt, however, of the value of the wash in controlling the scale upon the Pacific Coast, for it will be remembered, that more than thirty years ago (1873) this dreaded pest was found devastating the orchards in San Jose Valley, and soon became widely disseminated throughout that section of country. Yet the cultivation of deciduous fruits has in no wise abated, and despite the ravages of this insect and the consequent necessity for treatment, the Western growers are more than able to hold their own in competition with our fruits on the Eastern markets. The advent of the scale in Eastern orchards naturally suggested the use of this treatment so efficient in its control on the Pacific Coast. Soon after its discovery in the East, therefore, tests of the lime, sulfur and salt wash, along with several others used in the West, were made by the Division of Entomology of the U. S. Department of Agriculture. As a result of this experiment, the conclusion was reached that this wash would not be effective under our climatic conditions in the East, and the experiment in question appeared to warrant this conclusion.

Rather recently the lime, sulfur and salt wash has been taken up by certain orchardists in the East as a possible remedy for the scale, notwithstanding the current opinion that but little relief was to be expected from its use. In a general way the results, however, were quite satisfactory, and information to this effect found its way in the horticultural and agricultural papers of the country. In this State, Mr. S. S. Stouffer of Sharpsburg, was one of the first to make use of the lime, sulfur and salt wash. Concerning the wash, Mr. Stouffer writes under date of January 19, 1903, as follows:

"I first used the sulfur, lime and salt wash in the Spring of 1901. At that time my peach orchard was in bad shape. Quite a number of the trees were so badly coated with scale that the entire tops were killed and had to be pruned down so as to form new heads; a few trees were killed outright. My apple orchard was not so bad. The scale was scattered all over the trees, but none were coated. Although the weather conditions were not favorable, having frequent heavy rains and snow storms following the spraying operations, and before the spray had time to dry, the results were entirely satisfactory, killing at least 95 to 98 per cent of the scale, or every one with which the wash came in contact. I could not see any injury to the trees or buds, no matter how heavy the trees were coated with the spray. In fact I advise a liberal use, completely washing the trees. I do not think of using any other spray and consider it the cheapest, safest and most effective of any wash I have ever used. I sprayed about 1500 trees in 1901, about 4000 in 1902 and expect to treat twice as many this coming spring.

In preparing the sulfur, lime and salt spray, I use a common farm engine and boiler. From the dome of this boiler, a steam pipe should

extend out horizontally about 15 ft. with four downward extending $\frac{1}{2}$ inch pipes. I use a common oak barrel of about 50 gal. to each downward pipe, three barrels for boiling the spray, and one barrel for boiling water. In a tub or half barrel, place 30 lbs of good stone lime and slack with boiling water; pour into the first barrel, then take 15 lbs. of flour of sulfur and 8 lbs. of common salt and place in same barrel, fill about $\frac{2}{3}$ full of water. Now turn on the steam by opening valve above barrel, and in about 5 minutes the spray will be boiling. In 40 minutes charge the second barrel same as first, and in 40 minutes charge the third barrel. After the first



HOW THE WASH IS MADE IN CANADA.—AFTER FISHER.

barrel has been boiling two hours strain through a fine wire strainer into the spray barrel and enough boiling water is added to make 50 gallons. The barrel should be fastened on a one-horse wagon. One man will be required to work the pump and drive, and two men to take charge of and handle the nozzles (if two leads of hose are used.) Charging the barrels alternately, a barrel of 50 gallons may be sent to the orchard every 40 minutes. One man can attend to the engine and boiling of the spray, and a boy can haul the water as fast as needed. The spray is not only effective against the scale, but is a good fungicide, preventing peach leaf curl, rot, etc., leaving the tree vigorous and healthy.

The cost of material is about 55 to 60 cents per barrel of 50 gallon wash, and the cost of application is about 50 cents per barrel. I begin to spray in the spring as soon as the ground is dry enough to bear a team. As our seasons are more or less uncertain, sometimes too much rain or too windy, we must use all of the time to the best advantage."

Considerable notoriety followed the use of the wash by Mr. Samuel Creely, of Burlington County, New Jersey, who sprayed an infested peach orchard during the winter of 1900-1901. Much credit is due these gentlemen for their independence in adopting a treatment previously shown to be of but little value, and to such instances as these must be attributed, in a measure, the renewed interest in the wash, and the series of careful experiments made in the last year or so by several Eastern Entomologists.

Probably the most extensive experimental work thus far reported comes from Prof. S. A. Forbes, State Entomologist of Illinois, and reported in the Illinois Experiment Station Bulletins 71 and 72, issued in April and May respectively, 1902. It is here clearly shown that, contrary to the heretofore accepted belief, the insecticidal properties of the wash are not leached out by rains to the extent that it is rendered ineffective. In the eighteen different plats treated by Professor Forbes, the average per cent of scale killed by the wash is estimated, by careful count, to have been 99.2. These applications were made early in March. Similar good reports come from Georgia where the wash has been tried on a rather large scale, and reported in Bulletin 4 of the Georgia State Board of Entomology, page 20. In a recent bulletin issued by the New Jersey Experiment Station (No. 162), Dr. J. B. Smith, the New Jersey State Entomologist, presents a conservative statement of the results obtained from the use of this wash in New Jersey. On the whole the effectiveness of the wash is clearly shown, and its increasing use by the orchardists of that State indicates that it has been found to be very satisfactory. At the meeting of the Association of Economic Entomologists in Pittsburg in June last, Mr. A. F. Burgess, Official Inspector of the State of Ohio, reported good results from the tests thus far made with this wash in that State, and at a meeting of the same Association in Washington during the latter part of December, 1902, reports were presented detailing its successful use in Connecticut, Massachusetts and in Ontario. In a recent letter from Mr Geo E. Fisher, Horticultural Inspector, Freeman, Ontario he states that better results have come from the use of the lime, sulfur and salt wash than from any other substance tested. He adds that it will be largely used in that Province the present spring.

Our own tests of the wash in this State were begun in the spring of 1902, and were made in four different parts of the State, namely: at College Park, Prince George's County; at Sharpsburg and Boonsboro, in Washington county; and at Annapolis Junction in Howard county. Careful observations were made on these experiments from

time to time, and an exact record of weather conditions was kept. These results have been reported on in detail in Bulletin 37, New Series, Division of Entomology, U. S. Department of Agriculture, and need not be considered here. Examinations in June indicated that the wash possessed but comparatively little insecticidal value, and it was estimated at that time, by careful count, that not more than 50 per cent. of the scales had been killed by the treatment. At that time the oily fluid from the bodies of the females could be pressed out in great abundance, by running a knife blade flatwise over the infested parts. Young lice were very abundant, crawling here and there over the branches. Subsequent observations, however, showed that very few of the young scales, hatching from the females which had escaped the treatment, were able to successfully establish themselves on the trees. The comparatively few larvæ, which succeeded in settling, soon afterwards died, and in subsequent examinations it became increasingly evident that the scales were disappearing from the trees. By September 1st live scales were really very hard to find even on trees, that at the beginning of the year, had been very badly infested. The old scales had largely peeled off, leaving the bark much brighter and fresher, and the young lice had failed to establish themselves, or died shortly after settling down. It becomes apparent, therefore, that the insecticidal effect of the wash is much more prolonged than has heretofore been recognized, and that the full measure of its efficiency may not be evident until rather late in the season. As those who have used the lime, sulfur and salt solution know, the wash remains evident on the trees for a long time, and the explanation of this continued action is probably to be found in the supposition that the occasional rains leach out from the wash, still adhering to the trees, a sufficient quantity of the insecticidal principles to cause the death of the active larvæ and of those newly settled. The young lice are apparently much more susceptible to the sulfur compounds in the wash than the adults, and it appears probable that a very small quantity is sufficient to cause their death. Trees sprayed with the wash thus become more or less protected from infestation with the young lice in the course of their natural spread from one tree to another, and it becomes to some extent a preventive, which can hardly be said of any treatment heretofore recommended for the San Jose scale.

EFFECT ON THE TREE.

The lime, sulphur and salt wash is a strictly dormant tree treatment to be applied in late winter or early spring. If properly made according to the formula and applied at the time indicated, there is no danger of injury to the trees. It has been reported, however, that peach trees have been injured in California by deferred application too late in the spring. Other reports from the same State, however, are to the effect that peach trees may be sprayed,

even after the bloom has begun to open, without serious results. But it would appear desirable, particularly in the case of the peach, that the applications should have been finished two or three weeks before the time the buds should begin to swell. In order to secure the continued insecticidal effect of the wash to the fullest possible extent during the following summer, spring applications should be delayed as long as the condition of the trees will permit.

So much injury has followed the use of kerosene and crude petroleum in this and other States, that the success of the lime, sulfur and salt wash in the East is cause for congratulation to all concerned. To meet the conditions in this State, there has been need of a wash which could be applied with an ordinary spray pump. In many cases the work of spraying must be delegated to persons not skilled in the work, and who fail to give the necessary attention to secure satisfactory results from the more complicated pumps, such as the "Kerowater"; and the result has been that either too much or too little oil is discharged, causing injury to the trees and fruit buds, or on the other hand, resulting in failure to satisfactorily destroy the scale. Since the lime, sulfur and salt wash can be used in an ordinary barrel spray pump, such as is employed in the application of Bordeaux mixture, the necessity of the careful attention required by the kerowater pumps, it thus obviated, and there is but little possibility of the spray man doing injury to the trees by inattention to the work. There is apparently no danger in excessive applications. Another important advantage is that treated trees become whitened, due to the use of the lime, and it is thus possible to give a second treatment to touch up the limbs and twigs missed in the first, adding very much to the thoroughness of the work.

TIME OF APPLICATION.

As already stated, the lime, sulfur and salt wash is recommended only as a late winter or early spring treatment, before the trees have made a start. Experiments are in progress at the present time to determine whether or not fall and mid-winter treatments will be as effective, as applications made in early spring. Since the wash appears to be quite effective in destroying young scales hatching three, four or five months after its application, it is probable that its greatest usefulness will result from applications as late in the spring as the conditions of the tree will allow. However, since there are many suitable days for spraying in the fall and winter, it seems desirable that this point should be tested, and possibility of effective work at the times stated will be reported on in due time.

FORMULAS.

Considerable variation is to be noted in the formulas recommended in the different parts of the country. The formula generally used

in California, and the one which we have used in our experiment work in Maryland, is as follows :

Quick lime	40 pounds.
Sulfur	20 pounds.
Stock salt	15 pounds.
Water, to make	60 gallons.

According to Dr. J. B. Smith, the formula largely used in New Jersey is :

Quick lime	50 pounds.
Flowers of sulfur	50 pounds.
Stock salt	50 pounds.
Water, to make	150 gallons.

In some experiments reported by Mr. C. L. Marlatt, of the U. S. Department of Agriculture, the California formula was used with the exception that 30 instead of 40 pounds of lime were used. Mr. Marlatt remarks that in the ordinary formula, the lime is very much in excess, and remains as a pure lime sediment, and has to be kept in suspension by agitation. Mr. Stouffer has been using the wash with much success made according to the following formula :

Quick lime	30 pounds.
Sulfur	15 pounds.
Common salt	8 pounds.
Water, to make	50 gallons.

It will be noted, however, that the proportion, approximately, of one pound of sulfur to three gallons of water is constant, and it appears that this proportion should always be observed. In as much as the work of spraying Maryland orchards, is done largely with barrel pumps, holding approximately fifty gallons, it will frequently be more convenient to prepare the wash in fifty gallon quantities. The California formula reduced to furnish one barrel of the wash is as follows :

Quick lime	33 $\frac{1}{3}$ pounds.
Flour of sulfur	16 $\frac{2}{3}$ pounds.
Stock salt	12 $\frac{1}{2}$ pounds.
Water, to make	50 gallons.

PREPARATION.

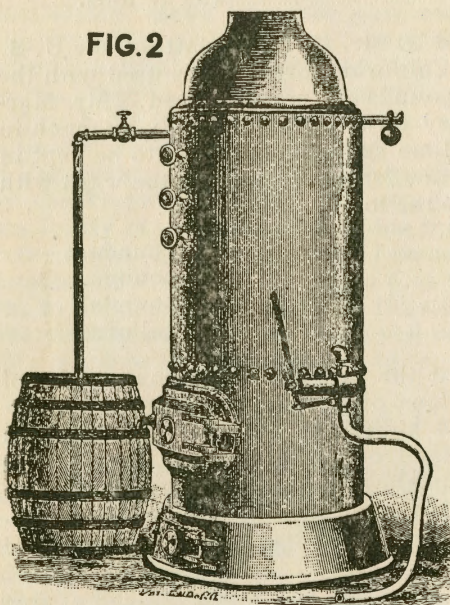
There is likewise considerable variation in the mode of preparation, but the California method is as follows :

Place ten pounds of lime and all of the sulfur in a boiler with twenty gallons of water. Boil over a brisk fire for not less than one hour and one-half, or until the sulfur is thoroughly dissolved. When

this takes place, the mixture will be of an amber color. Next place in a cask $23\frac{1}{3}$ pounds of unslacked lime, pouring over it enough hot water to thoroughly slack, and while it is boiling, add the $12\frac{1}{2}$ pounds of salt. When this is dissolved, add to the lime and sulfur in the boiler, and boil for half an hour longer, when the necessary amount of hot water to make the fifty gallons should be added. I would recommend adherence to the California formula and methods of preparation, until further experimentation shows a change to be desirable.

Some experimentation is reported, notably by Prof. N. B. Pierce, in charge of the Pacific Coast laboratory, F. W. Malley of the Government Entomological Department, Cape Town, South Africa, and by Mr. George E. Fisher, Freeman, Ontario, relative to what particular ingredients in the wash are insecticidal. The tests thus far reported all agree in saying that the lime and sulfur are essential, and the salt, aside from possibly rendering the wash more adhesive, may be omitted. After quite a series of tests of this wash in California, Mr. Pierce recommends the omission of salt, and further advises that all of the lime and sulfur be united and reduced with boiling water before the cooking begins. This procedure in the preparation of the wash will greatly simplify the work, but the well known influence of salt in whitewash to render it more adhesive, is reason for believing that under our conditions its use would be desirable.

FIG. 2



The wash is prepared as previously indicated, by boiling. It is very important that the ingredients should be boiled quite two hours to secure a properly made wash. The cooking may be done in an ordinary iron hog scald or in steam food cookers (see figure 1) or other suitable receptacles. Where a steam engine of any kind is available, it will be much better to cook the wash with steam. The steam should be conducted in the barrels or vats by means of pipes, which should extend to within a few inches of the bottom of the barrel. Where steam engines are not available and an orchard of considerable size is to be treated, it will be, in many cases, economi-

cal for the orchardist to purchase a small steam boiler such as shown in figures 2 and 3. Boilers of this size could be readily taken to the field, greatly facilitating the work of preparation of the wash, and would furnish sufficient steam to cook two or three barrels of the wash and keep a barrel of water hot at the same time. By the use of a horizontal feed pipe and vertical pipes, extending down into the barrels to within six inches of the bottom, each supplied with a valve, the cooking could be done with comparatively little annoyance. The barrels should be raised on a platform to facilitate the work of drawing off the wash. On the lower side of each barrel, about an inch from the bottom, a strong wooden faucet should be placed, so that the wash may be readily drawn off in buckets and poured into the spray pump barrel. By having the faucet somewhat above the bottom of the barrel, the excess of lime, which will have settled at the bottom, will be largely avoided. Barrels should be cleaned after the wash has been drawn off. The wash should be strained through a wire strainer, as it is poured into the spray pump barrel to remove any undissolved particles of lime, that might otherwise interfere with the proper action of the pump. After the proper amount of the prepared wash has been taken, sufficient hot water should be added to fill the spray pump barrel, making approximately fifty gallons. The wash should be applied quite warm. Should a quantity of the wash be left on hand at night, it should be well heated the following morning before applying, but this situation should be avoided as much as possible.

MODE OF APPLICATION.

Any pump furnishing a sufficient pressure may be used, and in general a nozzle that is satisfactory for the application of Bordeaux mixture will also be suitable for the lime, sulfur and salt wash. The "Pomona," "Eclipse" or "Century" barrel sprayers will be found suitable for the work. The pumps in which it is proposed to use the wash should be furnished with a strong agitator, otherwise the lime will settle to the bottom and tend to clog the strainer, as well as to give uneven results. In California, the Bean spray pumps (see figure 4) and nozzles are largely used. These are really compressed air sprayers and throw the wash with considerable force against the trees. The cylinders in the pumps are enameled inside, thus protecting them to a considerable extent from the corrosive action of the wash. After a pump has been used, it should be thoroughly cleaned. The hose and pump are very readily injured if the mixture is allowed to stand in them for any length of time. One of the serious drawbacks in the use of this wash is to be found in the fact that it is somewhat disagreeable to apply. The spray man, therefore, should provide himself with a rubber coat, hat and gloves, and many have found a pair of goggles, with clear glasses, very useful. The mode of application does not differ in the case of this wash from that of any other

spray material. The main point to be observed is, to take great care that all parts of the tree be treated. It is desirable that the hose be sufficiently long to enable the sprayer to get clear around the tree and finish it before leaving. The treated trees, upon drying, present a whitened appearance, very much as if whitewashed. It is consequently possible to detect any spots that have not been treated, and to go over them again. This renders possible much more thorough work than in the case of the other washes commonly used for the

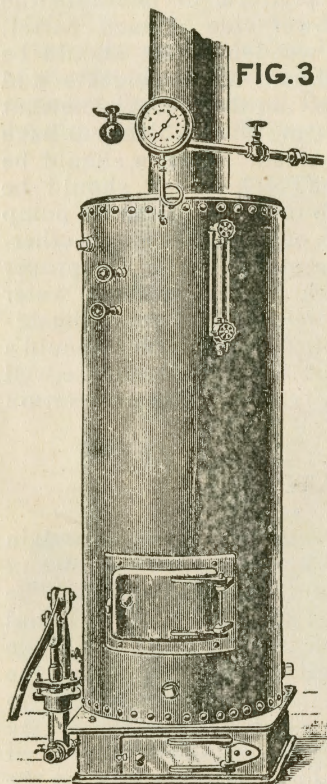


FIG. 3

San Jose scale. In all spraying operations, it is difficult to destroy the insect on the more terminal twigs. It is advisable, therefore, that previous to spraying, trees be given a heading back. This will not only add much to the beneficial results from the use of the wash, but, with several classes of fruit trees, the pruning will be of decided benefit. Previous to applying the wash to trees that have been seriously injured, they should be severely cut back. It becomes possible in this way to form a new top to the tree.

PUMPS AND OTHER ACCESSORIES.

As previously stated, any brass pump may be used, such as employed in the application of Bordeaux mixture. The wash, however, is very corrosive and especial attention should be given to cleaning the pump after using it. A strong agitator is essential, and the "Kerowater" pumps are, therefore, not suitable for his wash, unless the stirring is attended to by hand. The Bean Pneumatic Pump, shown in figure 4, is one largely used in California, and is

enameled to protect the parts from corrosive action of the wash. It is manufactured by the Bean Chamberlain Manufacturing Co., Hudson, Mich. Before ordering pumps secure catalogue of the following firms and select the one best suited to your needs: Griffith & Turner Co., Baltimore, who handle pumps for several firms; Gould Manufacturing Co., Seneca Falls, N. Y.; Morrill & Morley, Benton, Harbor, Mich.; Deming Co., Salem, Ohio; Spraymotor Co., London, Ont. Hog scalders, steam food cookers, boilers, etc., may be secured through the Griffith & Turner Co., Baltimore, or doubtless

from the following manufacturers: Marvin Smith Co., Chicago, Ill.; Electric Wheel Co., Quincy, Ill.; Crook & Horner Co., Baltimore, Md.; Thos. C. Basshor Co., Baltimore, Md. Where orchards of any considerable size are to be treated, the writer believes it will be economy in the long run to purchase a boiler, so that the cooking may be done by steam. While the initial cost will be greater, there will be a saving in time and labor and the wash is more likely to be better prepared than in open scalders or pots.

COST OF WASH.

The average cost of materials in each gallon of lime, sulfur and salt wash will be about one and-one-half cents. It may vary somewhat below this, or somewhat above, depending on the opportunities of the individual to buy the different materials. Sulfur is the most expensive ingredient. In some cases, *flowers of sulfur* is indicated in the formulas recommended. There appears to be no reason why *flour sulfur* will not be equally satisfactory, and this grade is somewhat cheaper, as noted below.

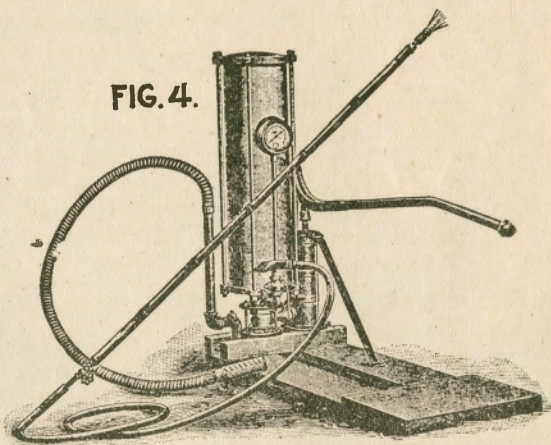


FIG. 4.

The Thomsen Chemical Company, of Baltimore, under date of January 9th, 1903, quote:

Flour Sulfur.....	250 lb. barrels at	\$2.40 per 100 lbs.
“ “	175 “ “ “	\$2.50 “ “ “
Flowers of Sulfur.....	150 “ “ “	\$2.60 “ “ “

f. o. b. Baltimore.

Quotations from both the Bergen Port Sulphur Works, and Battelle and Benwick, under date of January 12th, 1903, both firms in New York City, are:

Flour Sulfur.....	250 lb. barrels at	\$2.35 per 100 lbs.
“ “	175 “ “ “	\$2.45 “ “ “
Flowers of Sulfur.....		\$2.55 “ “ “

f. o. b. New York.

The cost of one and-one-half cents per gallon, does not include the cost of fuel, labor or any part of the outfit needed in its preparation and application. And it should be noted that more of the wash is required to secure a thorough coating of the trees than in the case of the oils. It will, however, be cheaper than the oil treatment, particularly at present prices of oil and much cheaper than the whale oil soap solution. Its principal advantages are, however, its effectiveness and the safety with which it may be used.